Complete Mesogastric Excisions Involving Anatomical and Embryological Factors

Subjects: Surgery

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Definition

Surgeries for gastrointestinal tract malignancies are based on the paradigm that we should remove the tumour together with its lymphatic drainage in one block. This concept was initially proposed in rectal surgery and called a total mesorectal excision.

1. Introduction

Gastric cancer is the fourth leading cause of death in worldwide cancer-associated deaths [1]. It is often diagnosed in the advanced stage. Treatment of patients with advanced gastric cancer still has poor prognoses [2]. Currently, the primary treatment for locally advanced gastric cancer is surgery. The standard surgical treatment for advanced gastric cancer worldwide is a gastrectomy with a D2 lymphadenectomy [3][4][5]. Rohatgi et al. have shown that despite radical surgical treatment, disease recurrence is observed in approximately 60% of patients [6].

The primary aim of gastrointestinal cancer surgery is an en block resection of the tumour together with its complex lymphovascular drainage that follows an organ's specific mesenteric layers [7]. The concept of an en block resection of the untouched fascia covering the mesenteric tissue mimicking an envelope is the basis for complete meso-excisions. Heald et al. proposed a revolution in rectal surgery by implementing a total mesorectal excision [8]. This procedure involves a sharp dissection following embryological planes with intact mesorectal fascia that covers not only the tumour but also lymphatic vessels and regional lymph nodes. Following this idea, the local recurrence rate in conventional surgery, which was as high as 33%, dropped after the implementation of TME to 10% [9]. A similar idea was proposed by Hochenberger et al. for colon cancer [10]. A complete mesocolic excision with a dissection of the mesocolic planes together with vascular ligation led to an improved short survival rate in a German group and in a Danish population-based study [11]. The idea of applying mesentery-based surgeries for a number of other organs became popular and was subsequently proposed. A meso-oesophageal resection of the thoracic oesophagus was proposed by Matsubara et al., while Cuesta et al. presented a minimally invasive meso-oesophageal model [12][13].

The idea of the mesopancreas was presented by Adham and Singhirunnusorn, and a recent study presented robotic mesopancreatic resections on 289 patients [14]. In all, with an increasing number of centres implementing this idea together with clinical data into daily practices, this technique has already shown huge potential in this area [14][15].

The idea of meso-excision was also proposed in gastric cancer resections.

Gastric cancer has four main routes of metastasis. These include a direct invasion of the tumour, lymphatic metastases, hematogenous metastases and peritoneal metastases. In 2012, Xie et al. hypothesized there may be a fifth pathway for the spread of gastric cancer cells called the metastasis V route [16]. This pathway differs from the other four classical metastatic pathways and cannot be removed by a standard D2 gastrectomy. Isolated tumour cells and small tumour nodules situated in the mesogastrium in adipose connective tissue have no direct link to the primary tumour or to lymphatic or vascular vessels. They proposed a third principle of radical gastrectomy, which is a complete mesogastrium excision (CME) [16]. As a new concept, this hypothesis needs further evidence, with preclinical as well as clinical studies, to become well established. In 2015, Xie et al. demonstrated the existence of the gastric mesentery and its structure. A model of the relationship between the stomach and the gastric mesentery surrounded by the proper fascia was then proposed. Previously unknown at that time, there are actually six anatomical structures formed between the embryological stage and the mature adult, and they consist of adipose tissue, lymph nodes and vessels. These help to fix the stomach to the posterior abdominal wall and were discovered and identified histologically. A CME using the Table Model technique and a tri-junction access was applied on a group of 105 patients to improve the conceptualization of gastric mesenteries [17]. The CME can also be called a systemic mesogastric excision or perigastic mesogastrium excision [18][19][20]. The CME was proposed by Xie et al.; however, a simple mesentery-based surgery that was the key to success in colorectal surgery is not that easy to implement during a gastrectomy because of various anatomical restrictions.

2. Mesogastrium

Due to the complexity of its structure, the mesogastrium is an anatomically unclassified structure. During embryological development, the tubular stomach and duodenum are connected to the posterior abdominal wall by a continuous mesentery. This mesentery consists of a double layer of peritoneum that surrounds the vessels, nerves and lymphatic pathways. As it grows and unfolds, the stomach begins to expand and twist to the left, clockwise around its longitudinal axis. At the same time, the pancreas, which is also a mesenteric component, arises from primitive buds in the duodenal wall. It then grows into the mesoduodenum and spleen, which is formed at the end of the first month of life, in the dorsal mesentery of the stomach, near its greater curvature, which is when it begins to enlarge [21][22].

During embryological development, both the stomach and duodenum are suspended by dorsal and ventral mesenteries from the parietal wall. During a 90-degree clockwise rotation along its longitudinal axis, the expansion of the dorsal mesogastrium into the upper abdomen occurs and is responsible for the formation of the omental bursa, which is fixed to the retroperitoneum. At the same time, there is a 270-degree counter-clockwise rotation of the primary midgut loop. The axis of rotation is the superior mesenteric artery. The transverse mesocolon moves closer to the dorsal mesogastrium. Both structures, the mesoduodenum and transverse mesocolon, are covered by the greater omentum, creating a derivative of the dorsal mesogastrium [23]. The creation of the mesopancreas is also an important part of the development of embryological planes and is important during mesogastric procedures in mesentery-based surgery for gastric neoplasms [23][24].

2.1. Mesogastrium: Translation of the Idea from the Mesocolon

Shinohara et al. have shown similarities between the mesogastrium and mesocolon based on their series of patients [24]. In a group of 157 mesosigmoid specimens, they reported similarities in the allocation of lymph nodes in three sectors of the mesocolon. These mainly included the peri-organ, the intermediate and a root in comparison with mesogastric lymph node stations 1–6; the second sector, including stations 7, 8 and 10–12; and the last third in sector 9. The number of lymph nodes by sectors decreases as per the convergence and represents 36.5 for the stomach, 18 and 4 for the abovementioned sectors and 16, 7 and 4 for the analogous sectors in the mesocolon. A lower proportion in the main nodes originating in the mesogastrium might be associated with the shorter length of the celiac trunk when compared with the inferior mesenteric artery.

2.2. Mesogastric Excision

In each segment of the mesogastric Table Model, various structures are situated, and different lengths and complexities are found between the segments [25]. There is a difference in length between the lesser and greater curvature mesenteries, with a much shorter length at the lesser mesentery and the upper part of the stomach; however, both shorter mesenteries are much more complex. A D1 + lymphadenectomy, according to Kumamoto et al., should be performed following the rules of a systemic mesogastric excision [19]. This group divided the D1 + lymphadenectomy for gastric cancer into four parts. The first part (the greater curvature segment) starts with a division of the greater omentum to open the bursa 3 cm from the gastroepiploic vessels up to the spleen. The left gastroepiploic vessels are then ligated at their roots. In case of a total gastrectomy, the additional dissection of the short gastric arteries up to the left cardia is performed. The second part (infrapyloric segment) of the dissection is between the mesoduodenum and greater omentum as well as the transverse colon. Infrapyloric lymph nodes are separated from the pancreas by following the intramesenteric dissectible layers. The third part (suprapancreatic and lesser curvature) starts with a dissection of the lesser curvature from the hepatoduodenal ligament up to the right cardia. The tissue with lymph nodes is separated from the intramesenteric dissectible layers. At this point, the tissues are separated from the arteries, including the proper hepatic, common hepatic and splenic arteries, and from the pancreas. Part four consists of a ligation of the right and left gastric vessels at their roots. Similar steps in a laparoscopic D2 lymphadenectomy using the CME concept have been presented by Cao et al.; however, they started by lifting the stomach upward and in a cephalic direction by the assist [26]. The suprapancreatic mesogastrium, which consists of the left gastric mesentery (LGM), the right gastric mesentery (RGM) and the PGM, is then exposed. Opening the serosal layer and identifying the retrogastric space starts with the exposition of the LGM. Then, a tissue separation of the gastroduodenal artery (GDA) from the duodenal side is performed exposing the RGM. Afterwards, the LGM mobilization and the removal of tissue at the common hepatic artery (CHA) are performed. This manoeuvre helps in finding the root of the left gastric artery that is also ligated at its origin. Dissection and ligation of the RGM is performed along the CHA and portal vein. The superior border of the splenic vessels is then cleaned from the adjacent tissues. The anterior lobe of the PGM is then lifted to find and ligate the posterior gastric vessels. The mesogastric Table Model.

3. Recurrence of GC after a D2 Gastrectomy

Surgical treatment with peri-operative chemotherapy is currently the only available method of treating advanced gastric cancer according to the current standards. The gold standard of radical surgical treatment of advanced gastric cancer is a total gastrectomy with a D2 lymphadenectomy. Unfortunately, a recurrence of the disease after radical surgery has been frequently reported [27][28][29][30][31][32]. The main causes of relapse are the potential spread of cancer cells during surgery or a minimal amount of cancer cells that have been left behind. Earlier studies have shown that cancer nodules in the mesogastrium can be as high as 8% [33]. Spolverato et al. stated that the recurrence rate of advanced gastric cancer is approximately 30–45% [34]. Rohatgi et al. have shown that, despite radical surgical treatment, disease recession was observed in approximately 60% of patients with advanced gastric cancer [6]. Likewise, Dickson et al. declared that, after radical surgery, 75–80% of patients had disease recurrence after two years [32]. Extra-nodal metastasis of cancer cells in adipose tissue was found in almost 40% of patients after a gastrectomy for T4a gastric cancer [35]. Broken dissected vessels during a gastric cancer lymphadenectomy may be responsible for cancer cell spillage into the peritoneal cavity [36].

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Keywords

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